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(54) **Electrophotographic recording apparatus and method of transferring a toner image**

Elektrophotographisches Aufzeichnungsgerät und Verfahren zur Übertragung eines Tonerbilds

Appareil de reproduction électrophotographique et méthode de transfert d'une image de développateur

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- **PATENT ABSTRACTS OF JAPAN vol. 18, no. 96 (P-1694) 16 February 1994 & JP-A-05 297 740 (CANON) 12 November 1993**
- **PATENT ABSTRACTS OF JAPAN vol. 14, no. 25 (P-991) 18 January 1990 & JP-A-01 265 282 (NIPPON TELEGR & TELEPH CORP.) 23 October 1989**
- **PATENT ABSTRACTS OF JAPAN vol. 16, no. 193 (P-1349) 11 May 1992 & JP-A-04 025 885 (CANON) 29 January 1992**
- **PATENT ABSTRACTS OF JAPAN vol. 17, no. 277 (P-1546) 27 May 1993 & JP-A-05 011 646 (CANON) 22 January 1993**

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EP 0 647 889 B1

Description

1. Field of the Invention:

The present invention relates to an electrophotographic recording apparatus such as an electrophotographic printer or an electronic copier.

2. Description of the Related Art:

An electrophotographic recording apparatus has a photosensitive drum. The surface of the photosensitive drum is first subjected to an electrostatic charge, then light is selectively given to the surface of the photosensitive drum by an exposure machine, thereby forming an electrostatic latent image thereon. The electrostatic latent image is developed when a developing machine supplies toner onto the surface of the photosensitive drum. When a medium such as paper, etc. is passed between the photosensitive drum and the developing machine, toner is attracted toward the medium from the photosensitive drum to be transferred onto the medium, thereby performing printing.

Fig. 2 is a view for explaining a transfer process. In the same figure, an electrostatic latent image formed on a photosensitive drum 11 is developed by a developing machine 12. A developed toner image is transferred onto a printing medium 15 by a transfer roller 13, which is subjected to an electrostatic charge by a transfer power source 14, so that the toner image is formed on the printing medium 15. A toner 16 on the printing medium 15 is thereafter fixed to the printing medium 15 by a fixing machine, not shown.

Inasmuch as transfer efficiency of the toner 16 from the photosensitive drum 11 onto the printing medium 15 is varied according to conditions at the time of transfer such as size of the medium, thickness of the medium, atmospheric humidity, and atmospheric temperature, it is necessary to change a voltage value to be applied from the transfer power source 14 to the transfer roller 13 (hereinafter referred to as transfer voltage) in accordance with these conditions.

For example, an envelope needs higher transfer voltage than a cut sheet of A4-size since the former is narrower and thicker than the latter.

EP-A-0520819 describes an electrophotographic printer which includes an arrangement for measuring the resistance of a transfer roller in a two stage process. The first stage provides an approximate value of the resistance of the transfer roller while the printer is warming up and the second stage generates an accurate value, given the approximate value generated in the first stage, immediately prior to printing. The second stage of resistance measurement may also account for the resistance of the transfer medium in addition to the resistance of the transfer roller.

EP-A-0404079 describes an electrophotographic printer in which the transfer roller comprises a double oxide (e.g. solid solution compounds containing zinc oxide and aluminium oxide) in an elastic member for the purpose of providing semiconductivity. The printer also includes a constant voltage control and a constant current control which are used to supply electric power to the transfer roller at different stages in the printing process, at least one of which stages takes account of the resistance of the transfer material to some extent.

It is an object of the invention to detect a value corresponding to a resistance value of a print medium which is inserted between the photosensitive drum and the developing machine, thereby obtaining a desired transfer voltage.

It is another object of the invention to detect the resistance value of the print medium by a high voltage power supply circuit per se for applying the transfer voltage to a transfer roller, thereby obtaining a desired transfer voltage.

It is still another object of the invention to estimate the resistance value of the print medium to thereby obtain a desired transfer voltage even in case that the resistance value is not directly measured because of instability of current supplied from the high voltage power supply circuit to the print medium.

According to a first aspect of the present invention there is provided an electrophotographic recording apparatus including a photosensitive drum and a transfer roller confronting said photosensitive drum, said electrophotographic recording apparatus further comprising:

a high-voltage power-supply circuit for applying a transfer voltage to said transfer roller, the high-voltage power-supply circuit including a transformer, which includes a primary coil with a first number of turns and a secondary coil with a second number of turns larger than the first number of turns, capacitor means connected to the primary coil inc parallel, and a switching element connected to the primary coil in series; and

a control circuit arranged to receive information of said electrophotographic recording apparatus including information of an output current value of said high-voltage power-supply circuit, which information is used to obtain a resistance value of a print medium, and to control a voltage value output from said high-voltage power-supply circuit;

wherein said control circuit calculates a value corresponding to a voltage value to be applied to said transfer roller based on a value which is varied in correspondence with a resistance value of said transfer roller and a resistance value of a print medium and outputs a control signal for controlling said voltage value which is supplied by said high-voltage power-supply circuit based on the calculated value.

According to a second aspect of the present invention there is provided a method of transferring toner im-

age in an electrophotographic recording apparatus which includes a photosensitive drum and a transfer roller confronting the photosensitive drum, said method comprising:

a step of measuring a resistance value Rr of said transfer roller before a print medium is introduced into said electrophotographic recording apparatus;
a step of inserting said print medium between said photosensitive drum and said transfer roller;
a step of detecting a first current value B1 at a first time ((1) in Figure 14) immediately after said print medium is inserted between said photosensitive drum and said transfer roller and a variation A1 of said first current value B1 which is varied during a very short period of time close to said first time while a constant voltage is applied to said transfer roller;
a step of detecting a second current value B2 at a second time ((2) in Figure 14) before the variation of said current comes to an end after said first time and a variation A2 of said second current value B2 which is varied during a very short period of time close to said second time;
a step of calculating a resistance value Rm of said print medium using a calculation formula: Rm = {(B2/B1)-1}/{(A2/A1)-(B2/V0)}; and a step of applying a voltage value to said transfer roller, said voltage value corresponding to a combined resistance Rr+Rm of the resistance value of said transfer roller and the resistance value of said print medium.

BRIEF DESCRIPTION OF THE DRAWINGS

Fig. 1 is a block diagram for explaining an electrophotographic recording apparatus according to a first embodiment of the present invention;
Fig. 2 is a schematic view of the electrophotographic recording apparatus for explaining a transfer process;
Fig. 3 is a circuit diagram of a high voltage power supply circuit according to the first embodiment of the present invention;
Fig. 4 is a timing chart of the high voltage power supply circuit;
Fig. 5 is a graph showing relation between current output from the high voltage power supply circuit and a detected current;
Fig. 6 is a graph showing characteristics of a pulse width modulation signal and the output voltage of the high voltage power supply circuit according to the first embodiment of the present invention;
Fig. 7 is a timing chart of the output voltage and output current according to the first embodiment of the present invention;
Fig. 8 is a calculation table showing transfer voltages according to the first embodiment of the present invention;
Fig. 9 is a view showing characteristic of an electrophotographic printer according to the first embodiment of the present invention;
Fig. 10 is a flow chart for explaining control procedure according to the first embodiment of the present invention;
Fig. 11 is a circuit diagram of a high voltage power supply circuit according to a second embodiment of the present invention;
Fig. 12 is a circuit diagram of an equivalent circuit of a transfer apparatus according to a third embodiment of the present invention;
Fig. 13 is a view showing variation of voltage Vtr when a given current is supplied to a transfer roller in Fig. 12;
Fig. 14 is a graph showing variation of current which flows to the transfer roller when the medium is inserted between the photosensitive drum and the transfer roller in Fig. 12; and
Fig. 15 is a circuit diagram of a high voltage power supply circuit according to a fourth embodiment of the present invention.

First Embodiment (Figs. 1 to 10):

An electrophotographic recording apparatus includes a control circuit as shown in Fig. 1 for controlling operations of a photosensitive drum 11, a developing machine 12, a transfer roller 13, a transfer power source 14, etc.

Fig. 1 is a block diagram for explaining an electrophotographic recording apparatus according to a first embodiment of the present invention. As the electrophotographic recording apparatus, an electrophotographic printer is exemplified and an operation of the electrophotographic printer will be described hereinafter.

A control circuit for controlling an entire electrophotographic printer is a one-chip CPU-LSI 28 comprising a CPU 21, a control logic circuit 22, an A/D converter 23 (A/D-C), and a pulse width modulation signal generator 24 (PWM-G) which are all mounted on a single silicon semiconductor.

A control program for operating the CPU-LSI 28 is stored in a ROM 29 and printing is performed according to the control program.

The control logic circuit 22 receives a print date from a host unit such as a personal computer by way of an input interface 31. The control logic circuit 22 further receives information detected by various medium sensors 37 and a set value of an operation panel 58.

The control logic circuit 22 outputs a dot data to be printed to an LED head 35 so that the LED head 35 can perform an exposure and outputs a control signal to a motor driver 42 so that the motor driver 42 can control a hopping motor 40 and a drum motor 41. The control logic circuit 22 further outputs a control signal to a heat controller 53 so that the heat controller 53 can control a temperature of a fixing machine 51. The control logic circuit 22 still further outputs a control signal to a charg-

ing/developing power source 44 so as to control a voltage value for electrostatic charge or developing.

The A/D converter 23 receives a detection signal SG2 comprising a voltage value corresponding to a current value output from a high voltage power supply circuit 48 to the transfer roller 13 and a voltage value corresponding to temperature detected by a temperature measuring thermistor 52 which is provided together with the heat controller 53 in the fixing machine 51.

The pulse width modulation signal generator 24 outputs a pulse width modulation signal SG1 corresponding to the voltage value output from the high voltage power supply circuit 48.

An operation of the CPU-LSI 28 will be described hereinafter.

The CPU-LSI 28 receives the above print information by way of an input interface and stores the print information temporarily in a RAM 32. The CPU-LSI 28 converts the print information stored in the RAM 32 into a dot data based on the information stored in a ROM 29 and stores again the dot data in another area of the RAM 32. The CPU-LSI 28 transfers the dot data to the LED head 35 in a given timing for performing exposure.

Moreover, the CPU-LSI 28 supplies a print medium to the electrophotographic printer in accordance with the conversion of the print information into the dot data.

The CPU-LSI 28 receives detection signals output from the various medium sensors 37 provided at the various positions for detecting presence or nonpresence of the medium and width of the medium, introducing the medium from a medium cassette and discharging the medium from a discharge port of the electrophotographic printer. When the medium is contained in the medium cassette, not shown, the CPU-LSI 28 controls the motor driver 42 so that the motor driver 42 drives the hopping motor 40 and drum motor 41 to feed the medium in a printing direction.

The CPU-LSI 28 outputs a pulse width modulation signal SG1 to thereby control the high voltage power supply circuit 48 so that the high voltage power supply circuit 48 applies the transfer voltage to the transfer roller 13.

The CPU-LSI 28 performs such various controls so as to sequentially perform exposing, developing, transferring and fixing processes for electrophotographic printing.

A power supply circuit 55 is a circuit for transforming a voltage of a commercial power source received through an AC input 56 thereof into stable voltages to be supplied to the high voltage power supply circuit 48 and other blocks in the electrophotographic printer as power source voltages.

Fig 3 is a circuit diagram of the high voltage power supply circuit 48 according to the first embodiment of the present invention.

The high voltage power supply circuit 48 includes a transformer T1 composed of a primary coil L1 for receiving a power source E of +5V and a secondary coil L2 which is larger than the primary coil L1 in number of turns for generating a voltage larger than that of the primary coil L1 in the secondary coil L2.

Connected to the ground side of the primary coil L1 are an inverse diode D1 and a transistor Tr1 which receives the pulse width modulation signal SG1 by way of a resistor Rb at a base terminal thereof. The primary coil L1 and its distributed capacity constitute a resonance circuit, the distributed circuit serving as a resonance capacitor C1 in an equivalent circuit.

A rectifier diode D2 and a smoothing capacitor C4 are connected to the output side of the secondary coil L2 and a noise filter capacitor C3 is connected to the smoothing capacitor C4 in series.

A current detecting resistor Rs is connected between a power source E and the ground side end of the smoothing capacitor C4 while a by-pass capacitor C2 for the high voltage power supply circuit 48 is connected between the power source E and the ground.

An operation of the high voltage power supply circuit 48 will be described with reference to Figs. 3 and 4.

Fig. 4 is a timing chart of the high voltage power supply circuit 48.

The pulse width modulation signal SG1 as shown in Fig. 4 is applied to the base terminal of the transistor Tr1 as shown in Fig. 3 by way of the resistor Rb which is provided for restricting the base current of the transistor Tr1. The pulse width modulation signal SG1 having a given cycle T is controlled in such a way as to prolong ON time $\underline{t}$ in the cycle T for outputting a high voltage and curtail the ON time $\underline{t}$ in the cycle T for outputting a low voltage. That is, the output voltage is controlled by the ratio of the ON/OFF times. Current from the power source E intermittently flows in the primary coil L1 of the transformer T1 under the ON/OFF control of the transistor Tr1.

The voltage of the primary coil L1 is multiplied by a ratio of the number of turns between the primary coil L1 and the secondary coil L2 to be output from the secondary coil L2. The current which flows from the secondary coil L2 is rectified by the rectifier diode D2 and is smoothed by the smoothing capacitor C4 so that an output voltage V0 is output from the high voltage power supply circuit 48 to be applied to the transfer roller 13.

At this time, a current which flows to the transfer roller 13, namely, an output current passes through the current detecting resistor Rs. A voltage V_{sg2} of the detection signal SG2 of the output current is expressed as follows as shown in Fig. 5.

$$V_{sg2} = 5 - I0 \cdot rs$$

wherein rs is a resistance value of the current detecting resistor Rs.

Fig. 5 is a graph showing the relation between the current I0 which is output from the high voltage power supply circuit 48 and the V_{sg2}.

As shown in Fig. 5, supposing that

rs = 500 CK [KΩ]

I0 = 10 [μA]

the following expression is established.

V_{sg2} = 0 [V]

Supposing that

I0 = 0 [μA],

the following expression is established.

V_{sg2} = 5 [V]

Accordingly, the CPU-LSI 28 can detect the V_{sg2} by way of the A/D converter 23 to monitor the output current I0.

As shown in Fig. 4, when the transistor Tr1 is turned on by the pulse width modulation signal SG1, current flows to the primary coil L1 and the current value of the primary coil L1 increases as time passes supposing that the inductance of the primary coil L1 is L1, the current value becoming after a time t:

Ic = Et/L1.

If the transistor Tr1 is thereafter turned off, resonance occurs in a resonance circuit constituted of the inductance L1 of the primary coil L1 and a capacitance C1 of the resonance capacitor C1 which is the distribution capacitance of the primary coil L1 of the transformer T1 in equivalent circuit. At this time, a peak value Vc_{peak} of the collector voltage Vc is the peak value Ic_{peak} of the collector current Ic multiplied by $\sqrt{L1/C1}$ so that the following expression is established;

$$Vc_{peak} = Ic_{peak} \cdot \sqrt{L1/C1}$$

$$= E \cdot t/\sqrt{L1 \cdot C1} \quad (1)$$

and resonance having a frequency fv of about $1/2\pi\sqrt{L1 \cdot C1}$ is generated. In this case, the negative half-cycle of the oscillating wave is clipped by the inverse diode D1 as shown in Fig. 3 and the collector voltage Vc is sharply attenuated.

It is understood from the expression (1) that the Vc_{peak} of the collector voltage Vc is increased in proportion to the lapse of time during which the collector current Ic flows.

Supposing that the cycle T of the pulse width modulation signal SG1 is 50 [μs], the frequency f is 20 [kHz], maximum value of t is 25 [μs], the primary coil inductance L1 of the transformer T1 is 500 [μH], the equivalent capacity C1 of the primary coil L1 of the transformer T1 due to the distribution capacitance thereof is 2000 [pF], the voltage of the power source E is 5[V] and the turn ratio of the transformer T1 is 1 : 30, the following expressions are established.

resonance cycle Tv = 6.3 [μs]

The peak value Ic_{peak} of the collector current Ic = 250 [mA]

(Average maximum value is 63 [mA])

The peak value Vc_{peak} of the collector voltage Vc = 125 [Vs]

Maximum value of the output voltage V0 = 3.75 [kV] (Vc peak × 30)

At this time, the current I0 which flows in the transfer roller 13 is very small, i.e. several [μA] to 10 [μA] since the printing medium 15 is inserted between the transfer roller 13 and the photosensitive drum 11 so that an output energy is, e.g., about 38 [mW]. On the other hand, an input energy is sufficiently large since it is expressed as follows.

$$0.25\ [A] \times (1/2) \times (1/2) \times 5\ [V] = 312\ [mW]$$

Accordingly, even if the output current I is varied, the voltage variation of the output voltage V0 is very little since a sufficient power is supplied from the primary coil L1.

Since the high voltage power supply circuit 48 having the arrangement as set forth above is subjected to a feedback control so as to supply a given voltage, it is not necessary to always detect the output voltage, which dispenses with the provision of an additional feedback control circuit. Further, it is not necessary to apply load to the CPU-LSI 28 instead of providing the additional feed back control circuit. Accordingly, it is possible to realize the high voltage power supply circuit 48 which can output a stable high voltage power supply by a simple circuit.

As mentioned above, the output voltage V0 is determined by the inductance L1, the equivalent capacitance C1 which is used as the resonance capacitor, the power supply voltage E and the time t. As a result, the relation between the pulse width modulation signal SG1 and the output voltage V0 of the high voltage power supply circuit 48 is established as shown in Fig. 6.

Fig. 6 is a graph showing characteristics of a pulse width modulation signal and the output voltage of the high voltage power supply circuit 48 according to the first embodiment of the present invention. As shown in Fig. 6, the output voltage V0 is proportional to the pulse width modulation signal SG1.

Although the distribution capacitance of the primary coil L1 is used as the resonance capacitor C1 in an equivalent circuit in the above example, it is necessary to provide another capacitor in parallel with the primary coil L1 if the distribution capacitance of the primary coil alone is not sufficient for the resonance capacitor C1.

An operation of the transfer roller 13 will be explained hereinafter.

Fig. 7 is a timing chart of the output voltage and output current according to the first embodiment of the present invention. In Fig. 7, denoted at V0 and I0 in the vertical axis are output voltage value and output current value of the high voltage power supply circuit 48 and the lateral axis represents time.

When printing operation starts and the photosensitive drum 11 shown in Fig. 2 starts to turn, the pulse

width modulation signal generator 24 shown in Fig. 1 generates the pulse width modulation signal SG1 and the high voltage power supply circuit 48 varies the output voltage V0 to a voltage V1 corresponding to the pulse width modulation signal SG1 only during a time ta. At this time, the current value of the output current I0 becomes I1, which is input to the CPU-LSI 28 as the detection signal SG2 to be monitored thereby. As a result, it is possible to calculate the resistance value of the transfer roller 13 per se.

When the printing medium 15 is fed and inserted between the photosensitive drum 11 and the transfer roller 13, the high voltage power supply circuit 48 varies the output voltage V0 to the voltage value V2 only during a time tb. At this time, the current value of the output current I0 becomes I2, which is also input to the CPU-LSI 28 as the detection signal SG2 to be monitored thereby. As a result, it is possible to calculate the combined resistance value of the transfer roller 13 and the printing medium 15.

The CPU-LSI 28 can calculate the resistance value of the printing medium 15 based on the resistance value at the state where the printing medium 15 is not present and the resistance value at the state where the printing medium 15 is present. The voltage VTR during printing can be calculated based on the resistance value.

In concrete, since the current values I1 and the I2 are detected relative to previously determined voltage values V1 and V2 respectively, the voltage VTR during printing can be obtained by way of a calculation table as shown in Fig. 8 without calculating the resistance value.

Fig. 8 is the calculation table showing transfer voltages according to the first embodiment of the present invention.

This calculation table can be stored in the ROM 29 in Fig. 1 and the voltage VTR during printing can be read out therefrom based on the detected current values I1 and I2. The pulse width modulation signal generator 24 generates the pulse width modulation signal SG1 corresponding to the voltage VTR during printing and the high voltage power supply circuit 48 keeps the output voltage V0 at the voltage value VTR during a time tc in response to the pulse width modulation signal SG1. At this time, the current value of the current I0 becomes ITR.

The calculation table in Fig. 8 shows the voltage value VTR which is calculated under the condition that the voltage value V1 is 500 [V] and the voltage value V2 is 1 [kV] according to the first embodiment.

The calculation table in Fig. 8 is set in the manner that the voltage value VTR is increased as the current values I1 and I2 of the output current I0 are decreased. This means that the resistance value of the transfer roller 13 is large in case the current value I1 is small when the current value I1 and the transfer roller 13 directly brought into contact with each other so as to permit the output voltage V0 to be voltage value V1. In this case, the voltage value VTR must be set to be large. It also means that the resistance value of the printing medium 15 is large in case the current value I2 is small when the printing medium 15 is inserted between the photosensitive drum 11 and the transfer roller 13 so as to permit the output voltage V0 to be voltage value V2. In this case, the voltage value VTR must be set to be large.

Thereafter, the CPU-LSI 28 applies the voltage value VTR to the transfer roller 13 as the transfer voltage by controlling the high voltage power supply circuit 48 to start the printing and returns the output voltage V0 of the high voltage power supply circuit 48 to 0V upon completion of printing.

The voltage value VTR which are set by the calculation table can be changed by operating the operation panel 58. The calculation table can be switched to another one depending on other conditions such as kinds or dimensions of the printing medium 15. For example, the size of the introduced medium is measured by a sensor and the calculation table is changed to another one according to the size of the medium so as to calculate an optimum transfer voltage, which leads to more fine control. Further, the voltage value VTR can be also calculated based on a given formula corresponding to the result of the calculation table instead of reading out the voltage value VTR from the calculation table.

Fig. 9 is a view showing the characteristic of an electrophotographic printer according to the first embodiment of the present invention.

In Fig. 9, solid curved lines respectively show ranges where the transfer is performed effectively in case of using thin paper, thick paper and an envelope as a medium on a normal transfer roller while curved broken lines respectively show ranges where the transfer is performed effectively in case of using the thin paper and the thick paper as the medium on a transfer roller which is larger in resistance value than the normal transfer roller by one or two digits. M in parenthesis shows that peripheral atmosphere of the electrophotographic printer is normal in temperature and humidity while L in parenthesis shows that peripheral atmosphere of the electrophotographic printer is low in temperature and humidity.

As mentioned above, a good transfer operation can be performed by calculating impedance of the medium and selecting the transfer voltage matching the same.

The aforementioned operations are summarized as follows.

Fig. 10 is a flow chart showing a sequence of controls mentioned above.

Step 1: the photosensitive drum 11 starts to rotate.

Step 2: the high voltage power supply circuit 48 (Fig. 1) permits the output voltage V0 to be voltage value V1 during the time ta alone (Fig. 7)

Step 3: the printing medium 15 is fed and inserted between the photosensitive drum 11 and the transfer roller 13

Step 4: the high voltage power supply circuit 48 permits the output voltage V0 to be voltage value V2

during the time tb alone.

Step 5: the CPU-LSI 28 reads out the voltage value VTR corresponding to the current values I1 and I2 from the calculation table shown in Fig. 8.

Step 6: the high voltage power supply circuit 48 permits the output voltage V0 to be the voltage value VTR during the time tc alone.

Step 7: printing starts

Step 8: the CPU 21 judges whether printing is completed or not. If printing is completed, the program goes to Step S9.

Step 9: the high voltage power supply circuit 48 returns the voltage value of the output voltage V0 to 0V.

As mentioned above, according to the first embodiment, the high voltage power supply circuit 48 can calculate the impedance of the transfer roller 13 and that of the printing medium 15 with ease by merely outputting the current value at the time when a given voltage is output as the detection signal SG2 to the A/D converter 23 and also it can set the transfer voltage corresponding to the impedance of the transfer roller 13 and that of the printing medium 15. As a result, it is possible to perform an effective transfer by a simple high voltage power supply circuit 48.

Second embodiment (Fig. 11):

An electrophotographic recording apparatus according to a second embodiment will be described with reference to Fig. 11, which is a circuit diagram of a high voltage power supply circuit.

A high voltage power supply circuit 48-2 of the second embodiment includes a sensor coil L3 for detecting an output voltage in addition to the high voltage power supply circuit 48 of the first embodiment and also includes a rectifier diode D3 and a smoothing capacitor C5 at the output side terminal of the sensor coil L3 from which an output voltage detection signal SG3 is output.

Since the voltage value of the output voltage detection signal SG3 is proportional to the output voltage V0, the CPU-LSI 28 can detect the voltage value of the output voltage detection signal SG3 by way of the A/D converter 23 to monitor the output voltage V0.

In such a manner, the CPU-LSI 28 can monitor the relation between the pulse width modulation signal SG1 and the output voltage V0 caused by the dispersion of the characteristic of parts constituting the high voltage power supply circuit 48-2. Since there is established a linear relation between the pulse width modulation signal SG1 and the output voltage V0, the CPU-LSI 28 can improve the accuracy of the output voltage V0 by monitoring the relation between the pulse width modulation signal SG1 and the output voltage V0 at one point and by performing calibration.

As mentioned above, it is possible to apply the transfer voltage corresponding to the medium to the transfer roller 13 by calculating the resistance value of the medium which is supplied to the electrophotographic recording apparatus or a value corresponding to the resistance value, thereby improving the transfer accuracy. However, it is difficult to measure the resistance value of the medium or the value corresponding thereto if the number of the print mediums per hour is increased.

To solve this problem, the medium resistance is estimated by an arithmetic operation based on difference between the current before the medium is supplied and the current immediately after the medium is supplied to the electrophotographic recording apparatus.

Third Embodiment (Figs. 12 to 14):

For this purpose, the resistance value of the print medium is measured as described in detail in the following third embodiment.

At first, a problem in measuring the resistance value of the print medium 15 in a short time will be described hereinafter.

Fig. 12 is a circuit diagram of an equivalent circuit of a transfer apparatus according to the third embodiment of the present invention.

In Fig. 12, denoted at Rd is an equivalent resistance of the photosensitive drum 11, Cm is an equivalent capacitance of the medium, Rm is an equivalent resistance of the medium, and Rr is an equivalent resistance of the transfer roller 13.

When the printing medium 15 is inserted between the photosensitive drum 11 and transfer roller 13, the equivalent resistance Rm and the equivalent capacitance Cm of the medium are inserted between the equivalent resistance Rd of the photosensitive drum 11 and the equivalent resistance Rr of the transfer roller 13, which corresponds to a state where a switch SWm is turned off. When the switch SWm is turned off, the transfer voltage is increased by the voltage corresponding to the equivalent resistance Rm of the medium. Accordingly, the transfer voltage is corrected by that corresponding to equivalent resistance Rm if a voltage Vtr is maintained at a given value during printing.

Whereupon, the variation of the voltage Vtr is delayed due to the equivalent capacitance Cm of the printing medium 15 at the instant when the printing medium 15 is inserted between the photosensitive drum 11 and the transfer roller 13 even if a given current value is supplied to the transfer roller 13 to detect the variation of the voltage Vtr. This is described more in detail with reference to Fig. 13.

Fig. 13 is a waveform showing the variation of voltage Vtr when a given current is supplied to the transfer roller 13. It is understood from Fig. 13 that it takes time until the voltage is stabilized after the insertion of the print medium 15. Accordingly, since printing operation starts shortly after the insertion of the medium in the electrophotographic recording apparatus having high printing speed, the medium reaches the printing area

before the voltage V_{tr} is stabilized and consequently the voltage difference becomes an error.

To overcome this problem, the resistance value of the printing medium 15 is calculated in the following manner.

In the equivalent circuit as shown in Fig. 12, if the resistance Rd of the photosensitive drum 11 is too small compared with other resistances to be neglected, a current characteristic as shown in a graph in Fig. 14 is obtained.

Fig. 14 is a graph showing variation of current which flows to the transfer roller 13 at the time of insertion of the medium.

The current value is the one when the voltage V0 is applied to the transfer roller 13 and it can be detected by the detection signal SG2.

The variation of current i at a detecting point (1) corresponding to the medium inserting time (t=0) is expressed as follows.

$$i = - \frac{V_0}{(R_r + R_m) \cdot R_r} \cdot (Rr + Rm \cdot e^{-\frac{t}{\tau}})$$

the variation of the current $\frac{di}{dt}$ is expressed as follows.

$$\frac{di}{dt} = - \frac{V_0 \cdot R_m}{(R_r + R_m) \cdot R_r} \cdot \frac{1}{\tau} \cdot e^{-\frac{t}{\tau}}$$

Assuming that current variation is A1 and current value is B1 at the detecting point (1), and current variation is A2 and current value is B2 at a detecting point (2) (an arbitrary time before the current is stabilized and expressed as t = t1), the following expressions are established.

$$A1 = - \frac{V_0 \cdot R_m}{(R_r + R_m) \cdot R_r} \cdot \frac{1}{\tau} \quad (a)$$

$$B1 = \frac{V_0}{P_r} \quad (b)$$

$$A2 = - \frac{V_0 \cdot R_m}{(R_r + R_m) \cdot R_r} \cdot \frac{1}{\tau} \cdot e^{-\frac{t1}{\tau}} \quad (c)$$

$$B2 = \frac{V_0}{(R_r + R_m) \cdot R_r} \cdot (R_r + R_m \cdot e^{-\frac{t1}{\tau}}) \quad (d)$$

From the expression of (a), the expression of (c) is expressed as follows.

Since

$$A2 = A1 \cdot e^{-\frac{t1}{\tau}},$$

$$e^{-\frac{t1}{\tau}} = \frac{A_2}{A_1} \quad (c')$$

From the expression of (c'), the expression of (d) is expressed as follows.

$$B2 = \frac{V_0}{(R_r + R_m) \cdot R_r} \cdot (R_r + \frac{A_2}{A_1} \cdot R_m) \quad (d')$$

Therefore, the following expression is established.

$$Rm = \frac{\frac{B_2}{V_0} R_r - 1}{\frac{A_2}{A_1} - \frac{B_2}{V_0}} \quad (d'')$$

By substitution of the expression of (b) into the expression of (d"), the following expression is established.

$$Rm = \frac{\frac{B_2}{B_1} - 1}{\frac{A_2}{A_1} - \frac{B_2}{V_0}}$$

Thus, it is possible to calculate the current value before the print medium 15 is inserted, the current value at an arbitrary time t1 before the current is stabilized, and the equivalent resistance Rm of the medium before the current value is stabilized by the output voltage V0 applied thereto.

A concrete control will be described hereinafter.

At first, the current value is measured before the insertion of the printing medium 15 (B1) and is again measured twice a little later thereafter, to obtain the variation rate (A1) of current from the difference between the two current values and the time lag therebetween.

Then, the current value is twice measured also at arbitrary times before the printing medium 15 reaches the printing position, and the variation rate (A2) of current is obtained by the difference between the two current values and the time lag therebetween. Average current value of these current values or one of the current values is assumed to be a current value (B2) at this time. It is preferable to use the average value when the current values B1 and the B2 are obtained but one of the current values may be used since the variation of the current value at this time is small compared with the current value per se.

Next, the resistance value of the printing medium 15 is calculated from the above formula before the print-

ing medium 15 reaches the printing position and the calculated resistance value of the printing medium 15 is added to the resistance value of the transfer roller 13 obtained from the current value before the insertion of the printing medium 15 so as to obtain the optimum transfer voltage corresponding to the composed resistance value from a table which is the calculation table of the first embodiment modified by changing a search key so that the voltage values may be obtain from the resistance values or obtain the optimum transfer voltage from a formula. The high voltage power supply circuit 48 is controlled so as to apply the optimum transfer voltage to the transfer roller 13.

As described above, it is possible to obtain an optimum transfer voltage, even in a high-speed electrophotographic printer incapable of directly measuring the resistance of the print medium, since the resistance of the medium can be calculated from the current value and current variation measured before printing.

The PWM signal is used as a control signal by the high voltage power supply circuits 48 and 48-2 according to the first and second embodiments, but the output voltage may be directly subjected to digital feedback control.

Fourth Embodiment (Fig. 15):

Fig. 15 is a circuit diagram of a high voltage power supply circuit according to a fourth embodiment of the present invention.

In Fig. 15, the high voltage power supply circuit includes a sensor coil L3 for monitoring the output voltage, which is reduced by a voltage divider constituted of resistors R70 and R71 to be input to one input terminal of a comparator 68. The other input terminal of the comparator 68 is connected to a desired reference voltage which is output from a D/A converter 64 of a one-chip microcomputer 60. The comparator 68 outputs a logical "H" when a detected voltage is higher than the reference voltage and outputs a logical "L" when the detected voltage is lower than the reference voltage. The output of the comparator 68 is input to the input terminal of a three-input AND circuit 69. Other input terminals of the AND circuit 69 are connected to a signal line coupled to an I/O port 66 of the one-chip microcomputer 60 and an output of an oscillator circuit 67. When the one-chip microcomputer 60 turns on high voltage output control, a logical "H" is output from the I/O 66. If the comparator 68 is at logical "H" at that time, the AND circuit 69 outputs a clock generated by the oscillation circuit 67. So long as the clock of the oscillator circuit 67 is applied to the transistor Tr1, a power is supplied to the transformer T1 so that the high voltage is output therefrom as V0.

The output current is converted into a voltage by a current-voltage converter circuit comprising resistors R73, R74, R75 and an operational amplifier 81 and the converted voltage is input to the A/D converter 65 of the one-chip microcomputer 60 to be monitored thereby.

The one-chip microcomputer 60 includes a CPU 61, a RAM 62 and a ROM 63 and it is connected to the CPU-LSI 28 by way of the I/O 66.

Using the high voltage supply power circuit according to the embodiments of the present invention, it is possible to perform an excellent printing without lowering the output voltage even in the electrophotographic recording apparatus which consumes much current for high speed printing.

Claims

1. An electrophotographic recording apparatus including a photosensitive drum and a transfer roller confronting said photosensitive drum, said electrophotographic recording apparatus further comprising:

   a high-voltage power-supply circuit for applying a transfer voltage to said transfer roller, the high-voltage power-supply circuit including a transformer (T1), which includes a primary coil (L1) with a first number of turns and a secondary coil (L2) with a second number of turns larger than the first number of turns, capacitor means connected to the primary coil in parallel, and a switching element (Tr1) connected to the primary coil in series; and

   a control circuit arranged to receive information of said electrophotographic recording apparatus including information of an output current value of said high-voltage power-supply circuit, which information is used to obtain a resistance value of a print medium to control a voltage value output from said high-voltage power-supply circuit;

   wherein said control circuit calculates a value corresponding to a voltage value to be applied to said transfer roller based on a value which is varied in correspondence with a resistance value of said transfer roller and a resistance value of a print medium and outputs a control signal for controlling said voltage value which is supplied by said high-voltage power-supply circuit based on the calculated value.

2. An electrophotographic recording apparatus according to Claim 1, wherein said control circuit further receives an output of a medium sensor and calculates a width of said print medium based on an output of said medium sensor and calculates a value which is varied in response to said resistance value of said transfer roller and said resistance value of said print medium and a value corresponding to said voltage value to be applied to said transfer roller based on the width of said print medium.

3. An electrophotographic recording apparatus ac-

cording to Claim 1, wherein said control circuit receives a set value of an operation panel and calculates a value which is varied corresponding to the resistance value of said transfer roller and the resistance value of said medium and also calculates a value corresponding to said voltage value to be applied to said transfer roller based on the set value of said operation panel.

4. An electrophotographic recording apparatus according to Claim 1, wherein said electrophotographic recording apparatus includes a memory device which stores therein information for operating said control circuit, and wherein said control circuit reads a formula for calculating said value from said memory device and calculates said value based on said formula.

5. An electrophotographic recording apparatus according to Claim 1, wherein said electrophotographic recording apparatus includes a memory device which stores therein information for operating said control circuit, and wherein said control circuit calculates said value referring to a calculation table which is stored in said memory device.

6. An electrophotographic recording apparatus according to Claim 1, wherein said control circuit includes a pulse width modulation signal generator for outputting said control signal to said high voltage power supply circuit so as to control a voltage of said high voltage power supply circuit based on a pulse width of said control signal.

7. An electrophotographic recording apparatus according to Claim 6, wherein said high voltage power supply circuit further comprises:

a smoothing circuit connected to said second coil; and
a first detection terminal for outputting a voltage value in response to a current value supplied from said high voltage power supply circuit.

8. An electrophotographic recording apparatus according to Claim 7, wherein said high voltage power supply circuit further includes a second detection terminal for outputting a voltage value corresponding to said voltage value supplied from said high voltage power supply circuit.

9. A method of transferring toner image in an electrophotographic recording apparatus which includes a photosensitive drum and a transfer roller confronting the photosensitive drum, said method comprising:

a step of measuring a resistance value Rr of said transfer roller before a print medium is introduced into said electrophotographic recording apparatus;
a step of inserting said print medium between said photosensitive drum and said transfer roller;
a step of detecting a first current value B1 at a first time ((1) in Figure 14) immediately after said print medium is inserted between said photosensitive drum and said transfer roller and a variation A1 of said first current value B1 which is varied during a very short period of time close to said first time while a constant voltage Vo is applied to said transfer roller;
a step of detecting a second current value B2 at a second time ((2) in Figure 14) before the variation of said current comes to an end after said first time and a variation A2 of said second current value B2 which is varied during a very short period of time close to said second time;
a step of calculating a resistance value Rm of said print medium using a calculation formula: Rm = {(B2/B1)-1}/{(A2/A1)-(B2/V0)}; and a step of applying a voltage value to said transfer roller, said voltage value corresponding to a combined resistance Rr+Rm of the resistance value of said transfer roller and the resistance value of said print medium.

Patentansprüche

1. Elektrophotographische Aufzeichnungsvorrichtung mit einer lichtempfindlichen Trommel und einer Übertragungswalze, die sich gegenüber der lichtempfindlichen Trommel befindet, wobei die elektrophotographische Aufzeichnungsvorrichtung ferner enthält:

eine Hochspannungs-Stromversorgungsschaltung zum Anlegen einer Übertragungsspannung an die Übertragungswalze, wobei die Hochspannungs-Stromversorgungsschaltung einen Transformator (T1), der eine Primärwicklung (L1) mit einer ersten Anzahl von Windungen und eine Sekundärwicklung (L2) mit einer zweiten Anzahl von Windungen, die größer als die erste Anzahl von Windungen ist, enthält, eine Kondensatoreinrichtung, die zur Primärwicklung parallelgeschaltet ist, sowie ein Schaltelement (Tr1), das mit der Primärwicklung in Serie geschaltet ist, umfaßt; und
eine Steuerschaltung, die so beschaffen ist, daß sie Informationen von der elektrophotographischen Aufzeichnungsvorrichtung empfängt, die Informationen eines Ausgangsstromwerts der Hochspannungs-StromversorgungsSchaltung enthalten, wobei die Informationen dazu

verwendet werden, einen Widerstandswert eines Druckmediums zu erhalten, um einen von der Hochspannungs-Stromversorgungsschaltung ausgegebenen Spannungswert zu steuern;
wobei die Steuerschaltung einen Wert, der einem an die Übertragungswalze angelegten Spannungswert entspricht, auf der Grundlage eines Werts berechnet, der entsprechend einem Widerstandswert der Übertragungswalze und einem Widerstandswert eines Druckmediums verändert wird, und auf der Grundlage des berechneten Werts ein Steuersignal zum Steuern des Spannungswerts, der von der Hochspannungs-Stromversorgungsschaltung ausgegeben wird, ausgibt.

2. Elektrophotographische Aufzeichnungsvorrichtung nach Anspruch 1, bei der die Steuerschaltung ferner einen Ausgang eines Mediumsensors empfängt und auf der Grundlage eines Ausgangs des Mediumsensors eine Breite des Druckmediums berechnet und auf der Grundlage der Breite des Druckmediums einen Wert, der sich als Antwort auf den Widerstandswert der Übertragungswalze und auf den Widerstandswert des Druckmediums verändert, sowie einen Wert berechnet, der dem an die Übertragungswalze anzulegenden Spannungswert entspricht.

3. Elektrophotographische Aufzeichnungsvorrichtung nach Anspruch 1, bei der die Steuerschaltung einen eingestellten Wert einer Bedienungskonsole empfängt und auf der Grundlage des eingestellten Werts der Bedienungskonsole einen Wert, der entsprechend dem Widerstandswert der Übertragungswalze und dem Widerstandswert des Mediums veränderlich ist, und außerdem einen Wert, der dem an die Übertragungswalze anzulegenden Spannungswert entspricht, berechnet.

4. Elektrophotographische Aufzeichnungsvorrichtung nach Anspruch 1, bei der die elektrophotographische Aufzeichnungsvorrichtung eine Speichervorrichtung enthält, die darin Informationen zum Betreiben der Steuerschaltung speichert, und bei der die Steuerschaltung eine Formel zum Berechnen des Werts von der Speichervorrichtung liest und den Wert auf der Grundlage der Formel berechnet.

5. Elektrophotographische Aufzeichnungsvorrichtung nach Anspruch 1, bei der die elektrophotographische Aufzeichnungsvorrichtung eine Speichervorrichtung enthält, die darin Informationen zum Betreiben der Steuerschaltung speichert, und bei der die Steuerschaltung den Wert unter Bezugnahme auf eine Berechnungstabelle, die in der Speichervorrichtung gespeichert ist, berechnet.

6. Elektrophotographische Aufzeichnungsvorrichtung nach Anspruch 1, bei der die Steuerschaltung einen Impulsbreitenmodulationssignal-Generator zum Ausgeben des Steuersignals an die Hochspannungs-Stromversorgungsschaltung enthält, um eine Spannung der Hochspannungs-Stromversorgungsschaltung auf der Grundlage der Impulsbreite des Steuersignals zu steuern.

7. Elektrophotographische Aufzeichnungsvorrichtung nach Anspruch 6, bei der die Hochspannungs-Stromversorgungsschaltung ferner enthält:

eine Glättungsschaltung, die an die Sekundärwicklung angeschlossen ist; und
einen ersten Erfassungsanschluß zum Ausgeben eines Spannungswerts als Antwort auf einen Stromwert, der von der Hochspannungs-Stromversorgungsschaltung geliefert wird.

8. Elektrophotographische Aufzeichnungsvorrichtung nach Anspruch 7, bei der die Hochspannungs-Stromversorgungsschaltung ferner einen zweiten Erfassungsanschluß enthält zum Ausgeben eines Spannungswerts, der dem von der Hochspannungs-Stromversorgungsschaltung gelieferten Spannungswert entspricht.

9. Verfahren zum Übertragen eines Tonerbildes in einer elektrophotographischen Aufzeichnungsvorrichtung, die eine lichtempfindliche Trommel und eine Übertragungswalze enthält, die sich gegenüber der lichtempfindlichen Trommel befindet, wobei das Verfahren enthält:

einen Schritt zum Messen eines Widerstandswerts R_r der Übertragungswalze vor der Einführung eines Druckmediums in die elektrophotographische Aufzeichnungsvorrichtung;
einen Schritt des Einschiebens des Druckmediums zwischen die lichtempfindliche Trommel und die Übertragungswalze;
einen Schritt des Erfassens eines ersten Stromwerts B1 zu einem ersten Zeitpunkt ((1) in Fig. 14) unmittelbar nach dem Einschieben des Druckmediums zwischen die lichtempfindliche Trommel und die Übertragungswalze sowie einer Veränderung A_1 des ersten Stromwerts B_1, der während einer sehr kurzen Zeitperiode in der Nähe des ersten Zeitpunkts verändert wird, während an die Übertragungswalze eine konstante Spannung V_0 angelegt wird;
einen Schritt des Erfassens eines zweiten Stromwerts B_2 zu einem zweiten Zeitpunkt ((2) in Fig. 14), bevor die Veränderung des Stroms nach dem ersten Zeitpunkt endet, und einer Veränderung A_2 des zweiten Stromwerts B_2, der während einer sehr kurzen Zeitperiode in

der Nähe des zweiten Zeitpunkts verändert wird;
einen Schritt des Berechnens eines Widerstandswerts R_m des Druckmediums unter Verwendung der Berechnungsformel: $R_m = \{(B_2/B_1)-1\}/\{(A_2/A_1)-(B_2/V_0)\}$; und
einen Schritt des Anlegens eines Spannungswerts an die Übertragungswalze, wobei der Spannungswert einem kombinierten Widerstand $R_r + R_m$ des Widerstandswerts der Übertragungswalze und des Widerstandswerts des Druckmediums entspricht.

Revendications

1. Appareil d'enregistrement électrophotographique incluant un tambour photosensible et un rouleau de transfert faisant face audit tambour photosensible, ledit appareil d'enregistrement électrophotographique comprenant en outre :

   un circuit d'alimentation à haute tension destiné à appliquer une tension de transfert audit rouleau de transfert, ledit circuit d'alimentation à haute tension incluant un transformateur (T1) qui contient un enroulement primaire (L1) avec un premier nombre de tours et un enroulement secondaire (L2) avec un second nombre de tours plus grand que le premier nombre de tours, un moyen formant condensateur connecté en parallèle à l'enroulement primaire et un élément (Tr1) de commutation connecté en série à l'enroulement primaire ; et
   un circuit de commande agencé pour recevoir de l'information dudit appareil d'enregistrement électrophotographique, y compris de l'information d'une valeur de courant de sortie dudit circuit d'alimentation à haute tension, laquelle information sert à obtenir une valeur de résistance d'un support d'impression pour commander une valeur de tension sortie dudit circuit d'alimentation à haute tension ;
   dans lequel ledit circuit de commande calcule une valeur correspondant à une valeur de tension à appliquer audit rouleau de transfert, en se basant sur une valeur qui varie en correspondance avec une valeur de résistance dudit rouleau de transfert et une valeur de résistance d'un support d'impression, et sort un signal de commande destiné à commander ladite valeur de tension qui est délivrée par ledit circuit d'alimentation à haute tension en se basant sur la valeur calculée.

2. Appareil d'enregistrement électrophotographique selon la revendication 1, dans lequel ledit circuit de commande reçoit en outre une sortie d'un capteur de support et calcule une largeur dudit support d'impression en se basant sur une sortie dudit capteur de support et calcule une valeur qui varie en réponse à ladite valeur de résistance dudit rouleau de transfert et à ladite valeur de résistance dudit support d'impression et une valeur correspondant à ladite valeur de tension à appliquer audit rouleau de transfert en se basant sur la largeur dudit support d'impression.

3. Appareil d'enregistrement électrophotographique selon la revendication 1, dans lequel ledit circuit de commande reçoit, d'un écran de mise en oeuvre, une valeur fixée et calcule une valeur qui varie en fonction de la valeur de résistance dudit rouleau de transfert et de la valeur de résistance dudit support, et calcule aussi une valeur correspondant à ladite valeur de tension à appliquer audit rouleau de transfert en se basant sur la valeur fixée dudit tableau de mise en oeuvre.

4. Appareil d'enregistrement électrophotographique selon la revendication 1, dans lequel ledit appareil d'enregistrement électrophotographique comprend un dispositif de mémorisation qui mémorise de l'information destinée à mettre en oeuvre ledit circuit de commande, et dans lequel ledit circuit de commande lit, dans ledit dispositif de mémorisation, une formule destinée à calculer ladite valeur, et calcule ladite valeur en se basant sur ladite formule.

5. Appareil d'enregistrement électrophotographique selon la revendication 1, dans lequel ledit appareil d'enregistrement électrophotographique comprend un dispositif de mémorisation qui mémorise de l'information destinée à mettre en oeuvre ledit circuit de commande, et dans lequel ledit circuit de commande calcule ladite valeur en se référant à une table de calcul qui est mémorisée dans ledit dispositif de mémorisation.

6. Appareil d'enregistrement électrophotographique selon la revendication 1, dans lequel ledit circuit de commande contient un générateur de signaux à modulation de largeur d'impulsion destiné à sortir ledit signal de commande vers ledit circuit d'alimentation à haute tension de façon à commander une tension dudit circuit d'alimentation à haute tension en se basant sur une largeur d'impulsion dudit signal de commande.

7. Appareil d'enregistrement électrophotographique selon la revendication 6, dans lequel ledit circuit d'alimentation à haute tension comprend en outre :

   un circuit de lissage connecté audit second enroulement ; et
   une première borne de détection destinée à

sortir une valeur de tension en réponse à une valeur de courant délivrée par ledit circuit d'alimentation à haute tension.

8. Appareil d'enregistrement électrophotographique selon la revendication 7, dans lequel ledit circuit d'alimentation à haute tension comprend en outre une seconde borne de détection destinée à sortir une valeur de tension correspondant à ladite valeur de tension délivrée par ledit circuit d'alimentation à haute tension.

9. Procédé de transfert d'une image en toner dans un appareil d'enregistrement électrophotographique qui comprend un tambour photosensible et un rouleau de transfert faisant face audit tambour photosensible, ledit procédé comprenant :

une étape de mesure d'une valeur de résistance R_r dudit rouleau de transfert avant l'introduction d'un support d'impression dans ledit appareil d'enregistrement électrophotographique ;
une étape d'introduction dudit support d'impression entre ledit tambour photosensible et ledit rouleau de transfert ;
une étape de détection d'une première valeur de courant B1 à un premier instant ((1) à la figure 14) immédiatement après l'introduction dudit support d'impression entre ledit tambour photosensible et ledit rouleau de transfert et d'une variation A1 de ladite première valeur B1 de courant qui a varié pendant une période de temps très courte proche dudit premier instant, pendant que l'on applique une tension constante Vo audit rouleau de transfert ;
une étape de détection d'une seconde valeur B2 de courant à un second instant ((2)à la figure 14) avant que la variation dudit courant prenne fin après ledit premier instant et d'une variation A2 de ladite seconde valeur B2 de courant qui a varié pendant une période de temps très courte proche dudit second instant ;
une étape de calcul d'une valeur Rm de résistance dudit support d'impression en utilisant une formule de calcul : Rm = {(B2/B1) - 1}/{(A2/A1) - (B2/VO)} ; et une étape d'application d'une valeur de tension audit rouleau de transfert, ladite valeur de tension correspondant à une résistance combinée Rr+Rm de la valeur de résistance dudit rouleau de transfert et de la valeur de résistance dudit support d'impression.

FIG. 1

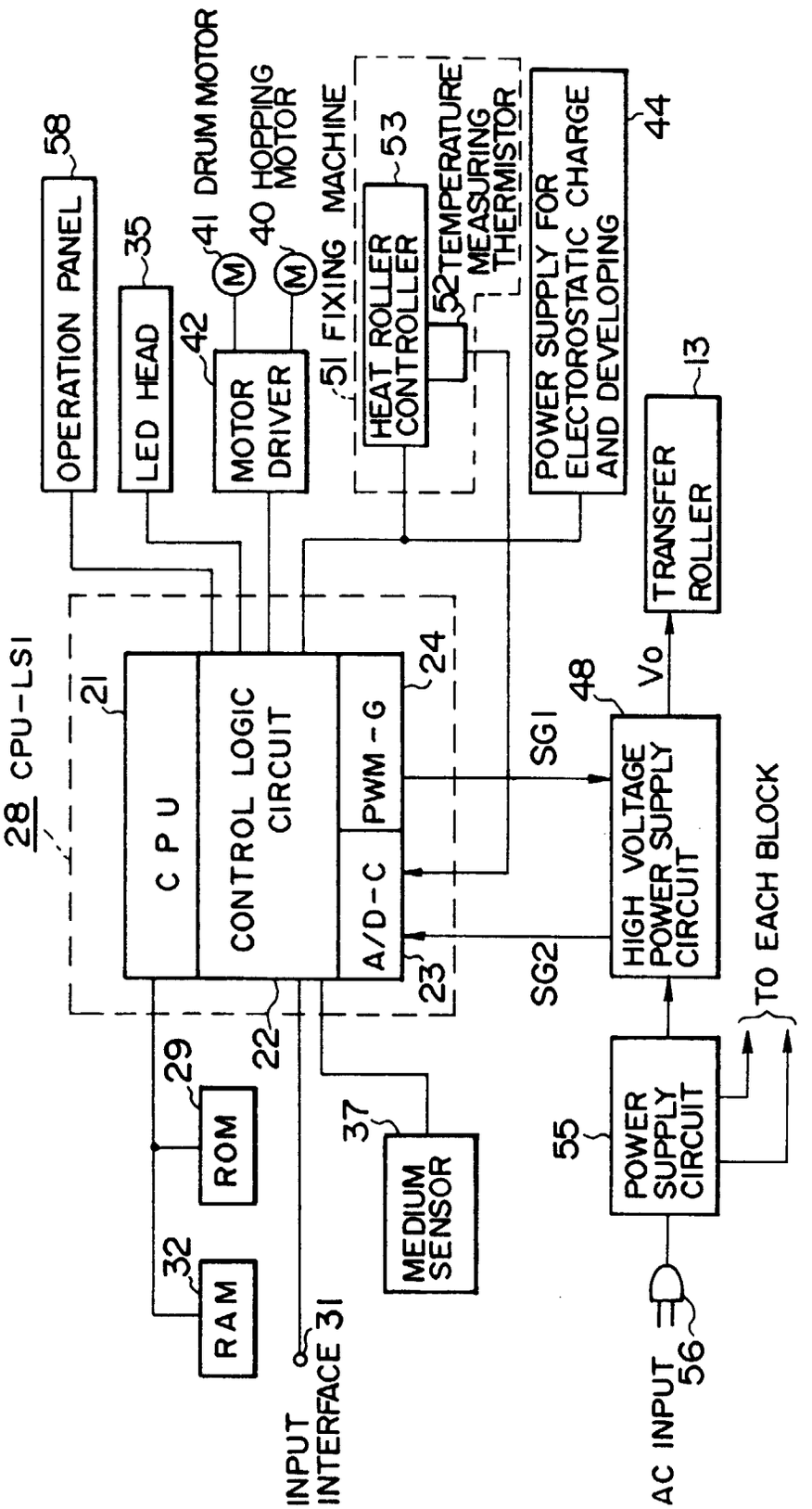

28 CPU-LSI
21
CPU
CONTROL LOGIC CIRCUIT
PWM-G
A/D-C
24
23
22
OPERATION PANEL
58
LED HEAD
35
MOTOR DRIVER
42
41 DRUM MOTOR
40 HOPPING MOTOR
51 FIXING MACHINE
HEAT ROLLER CONTROLLER
53
52 TEMPERATURE MEASURING THERMISTOR
POWER SUPPLY FOR ELECTOROSTATIC CHARGE AND DEVELOPING
44
TRANSFER ROLLER
13
Vo
48
SG1
SG2
HIGH VOLTAGE POWER SUPPLY CIRCUIT
TO EACH BLOCK
ROM
29
RAM
32
MEDIUM SENSOR
37
INPUT INTERFACE 31
POWER SUPPLY CIRCUIT
55
AC INPUT
56

FIG. 2

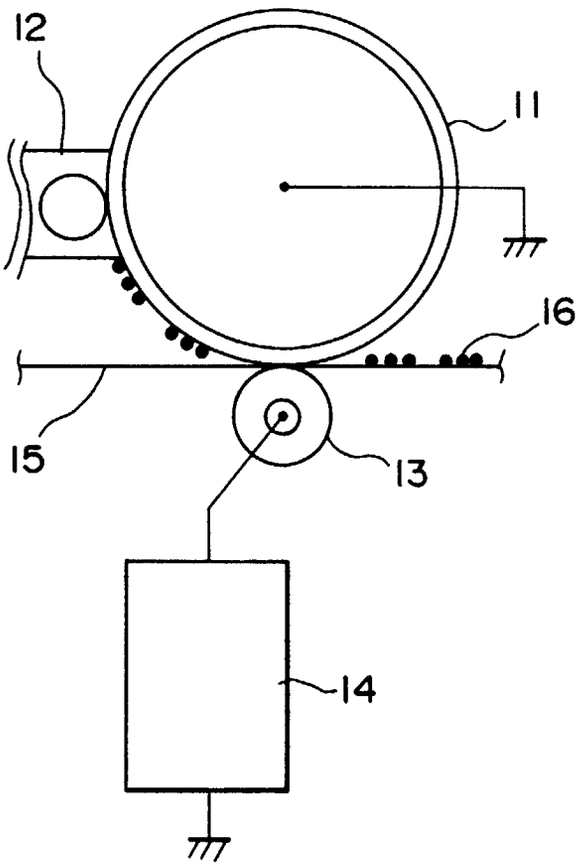


FIG. 3

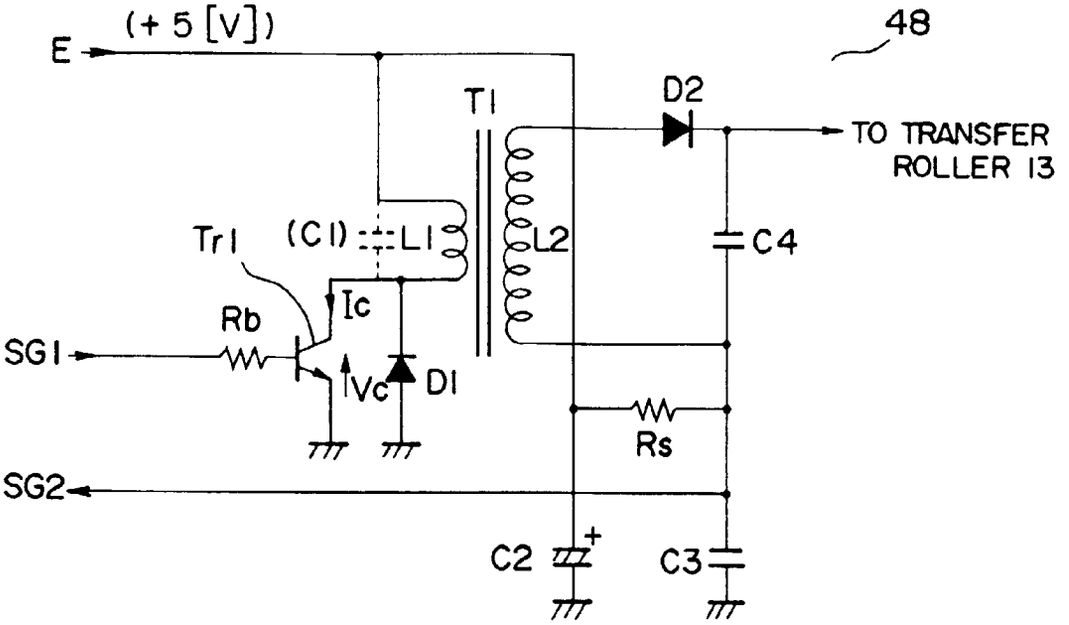

E
(+ 5 [V])
48
T1
D2
TO TRANSFER ROLLER 13
Tr1
(C1)
L1
L2
C4
Ic
Rb
SG1
Vc
D1
Rs
SG2
C2
C3

FIG. 4

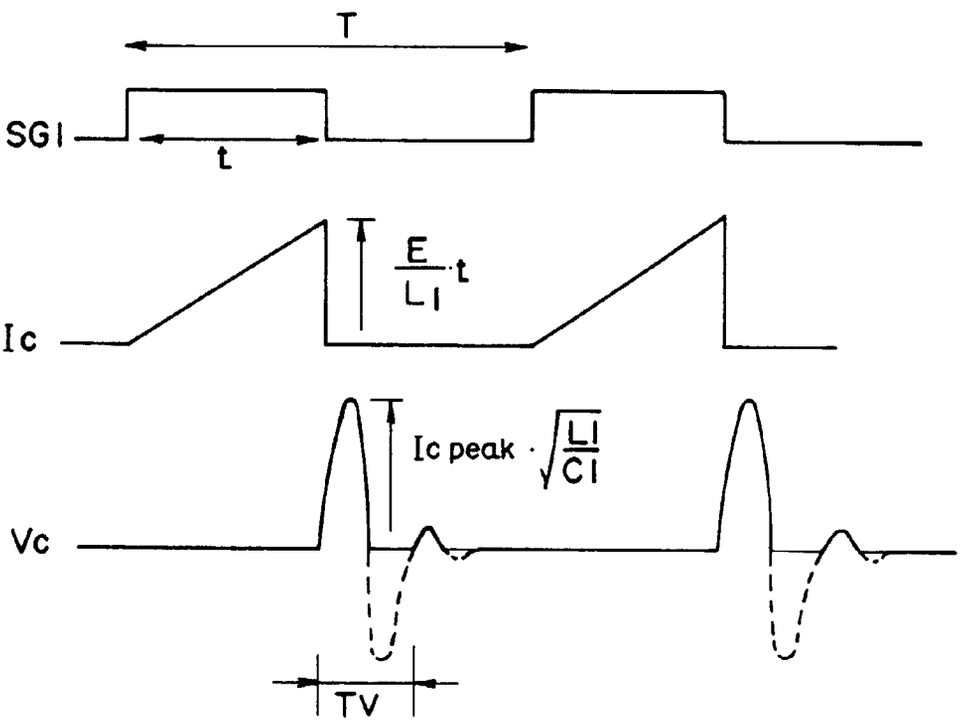

T
SG1
t
Ic
E/L1 · t
Vc
Ic peak · √(L1/C1)
Tv

FIG. 5

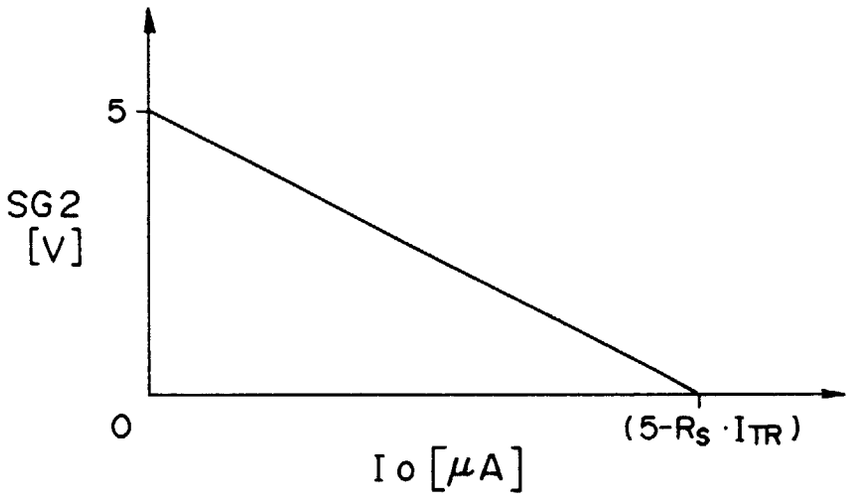


FIG. 6

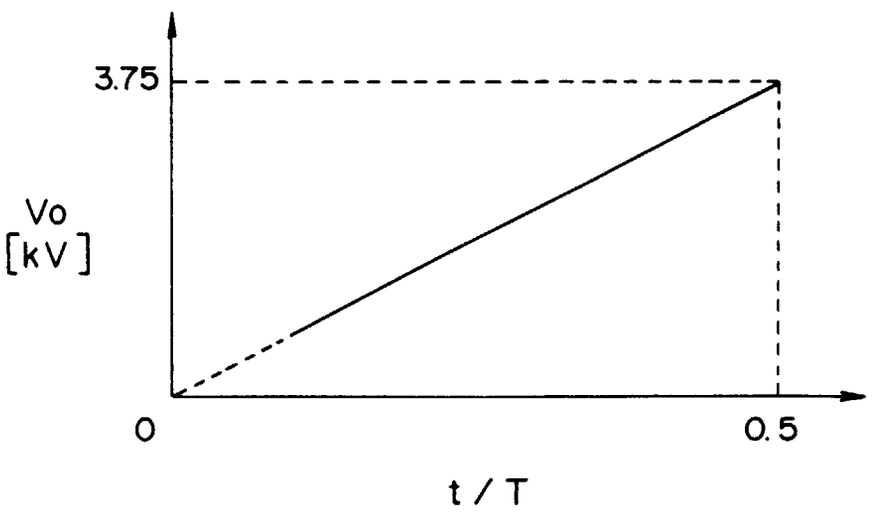


FIG. 7

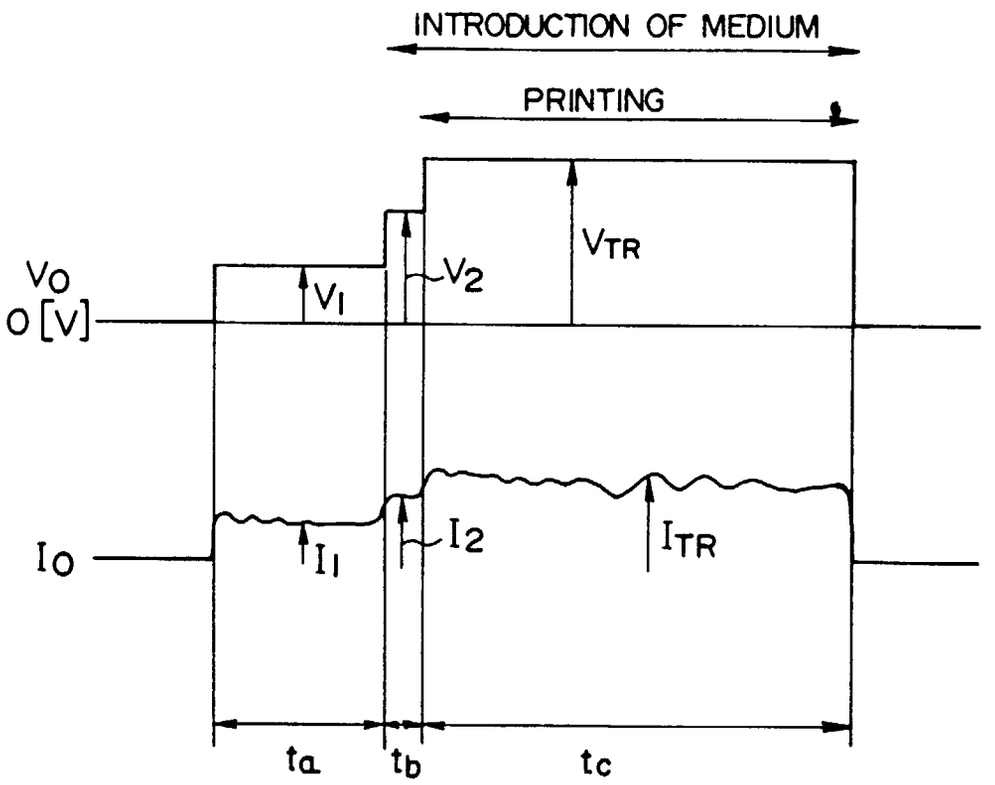
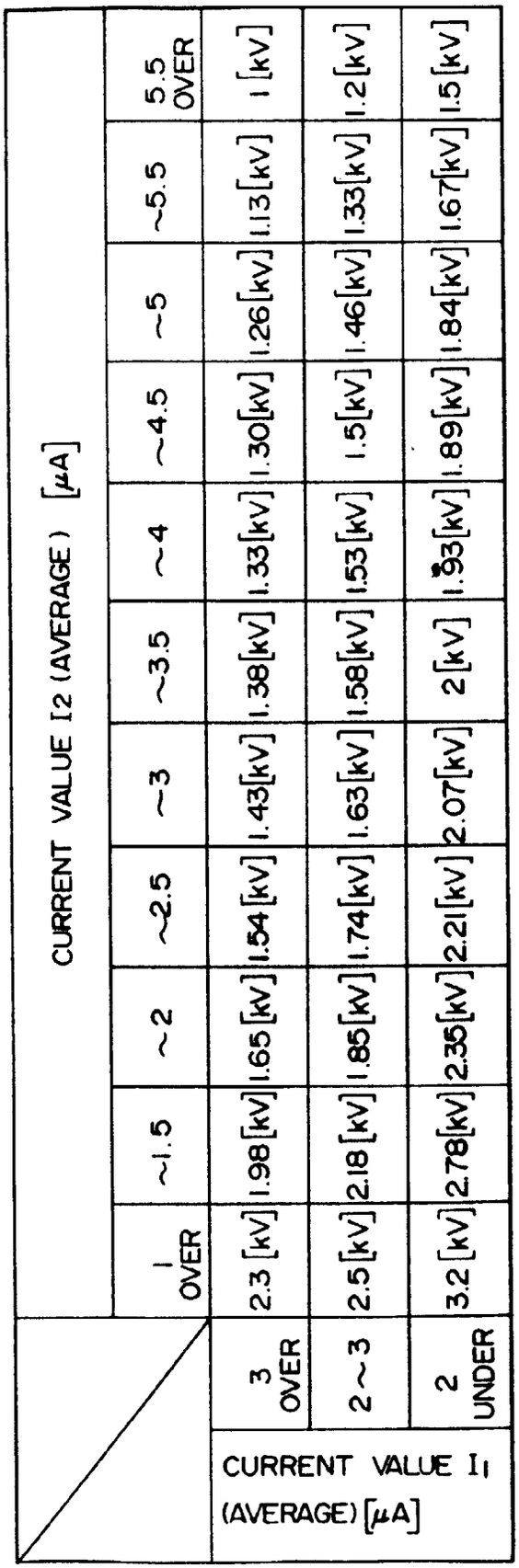

INTRODUCTION OF MEDIUM
PRINTING
VO
O [V]
V1
V2
VTR
IO
I1
I2
ITR
ta
tb
tc

FIG. 8



CURRENT VALUE I_1 (AVERAGE) [μA] \ CURRENT VALUE I_2 (AVERAGE) [μA]	1 OVER	~1.5	~2	~2.5	~3	~3.5	~4	~4.5	~5	~5.5	5.5 OVER
3 OVER	2.3 [kV]	1.98[kV]	1.65 [kV]	1.54 [kV]	1.43[kV]	1.38[kV]	1.33[kV]	1.30[kV]	1.26[kV]	1.13[kV]	1 [kV]
2~3	2.5[kV]	2.18 [kV]	1.85[kV]	1.74[kV]	1.63[kV]	1.58[kV]	1.53[kV]	1.5[kV]	1.46[kV]	1.33[kV]	1.2[kV]
2 UNDER	3.2 [kV]	2.78[kV]	2.35[kV]	2.21[kV]	2.07[kV]	2[kV]	1.93[kV]	1.89[kV]	1.84[kV]	1.67[kV]	1.5[kV]

FIG. 9

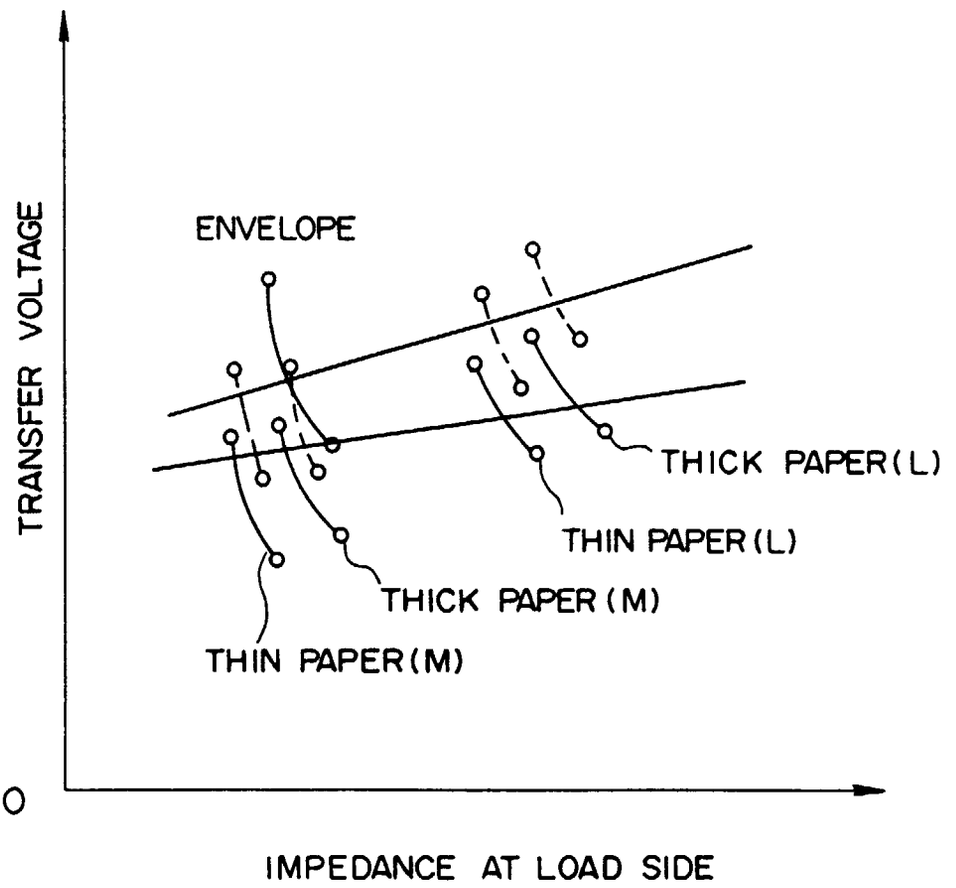

TRANSFER VOLTAGE
ENVELOPE
THICK PAPER(L)
THIN PAPER(L)
THICK PAPER(M)
THIN PAPER(M)
O
IMPEDANCE AT LOAD SIDE

FIG.10

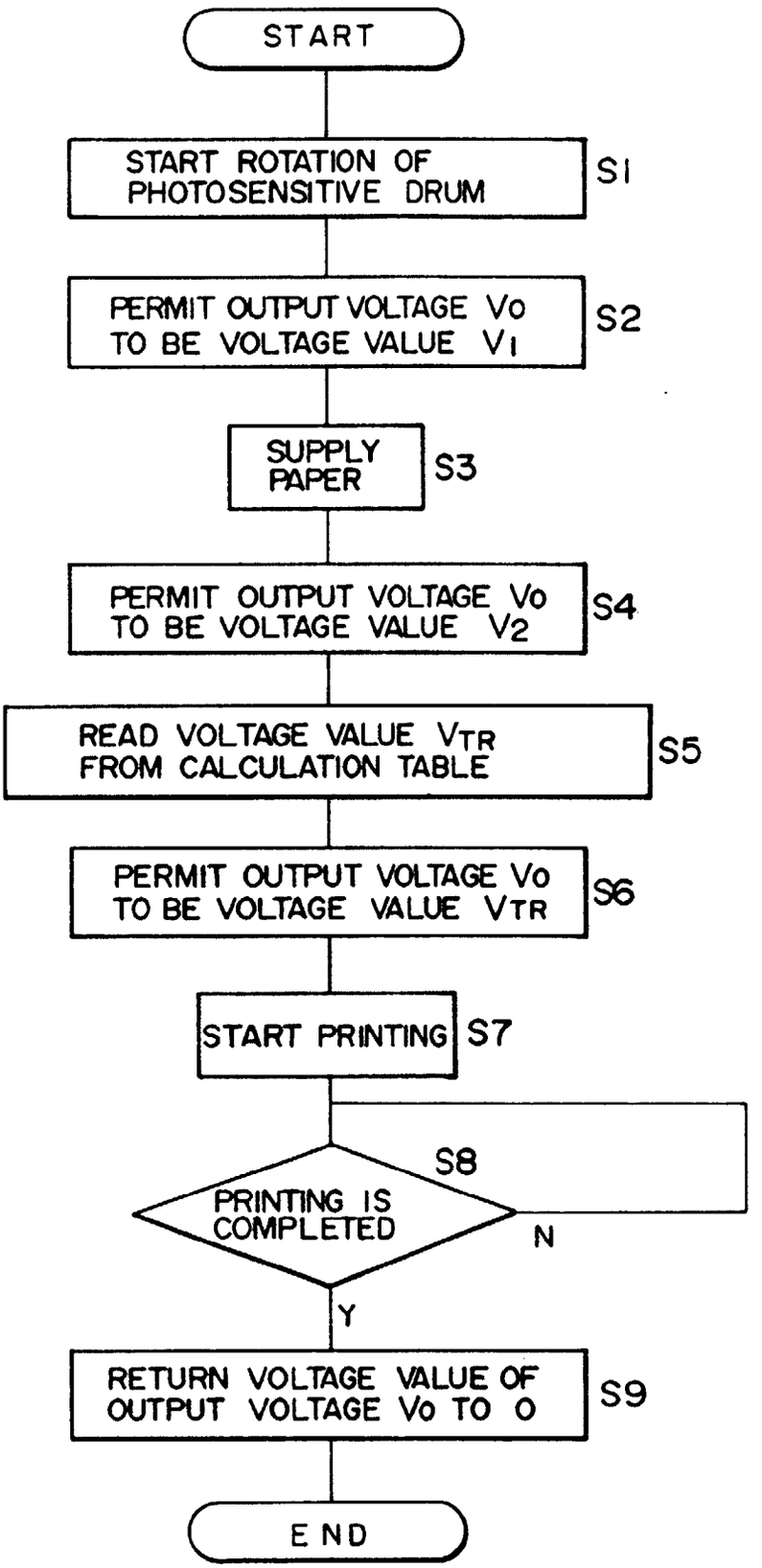

START
START ROTATION OF PHOTOSENSITIVE DRUM
S1
PERMIT OUTPUT VOLTAGE Vo TO BE VOLTAGE VALUE V1
S2
SUPPLY PAPER
S3
PERMIT OUTPUT VOLTAGE Vo TO BE VOLTAGE VALUE V2
S4
READ VOLTAGE VALUE VTR FROM CALCULATION TABLE
S5
PERMIT OUTPUT VOLTAGE Vo TO BE VOLTAGE VALUE VTR
S6
START PRINTING
S7
S8
PRINTING IS COMPLETED
N
Y
RETURN VOLTAGE VALUE OF OUTPUT VOLTAGE Vo TO 0
S9
END

FIG. 11

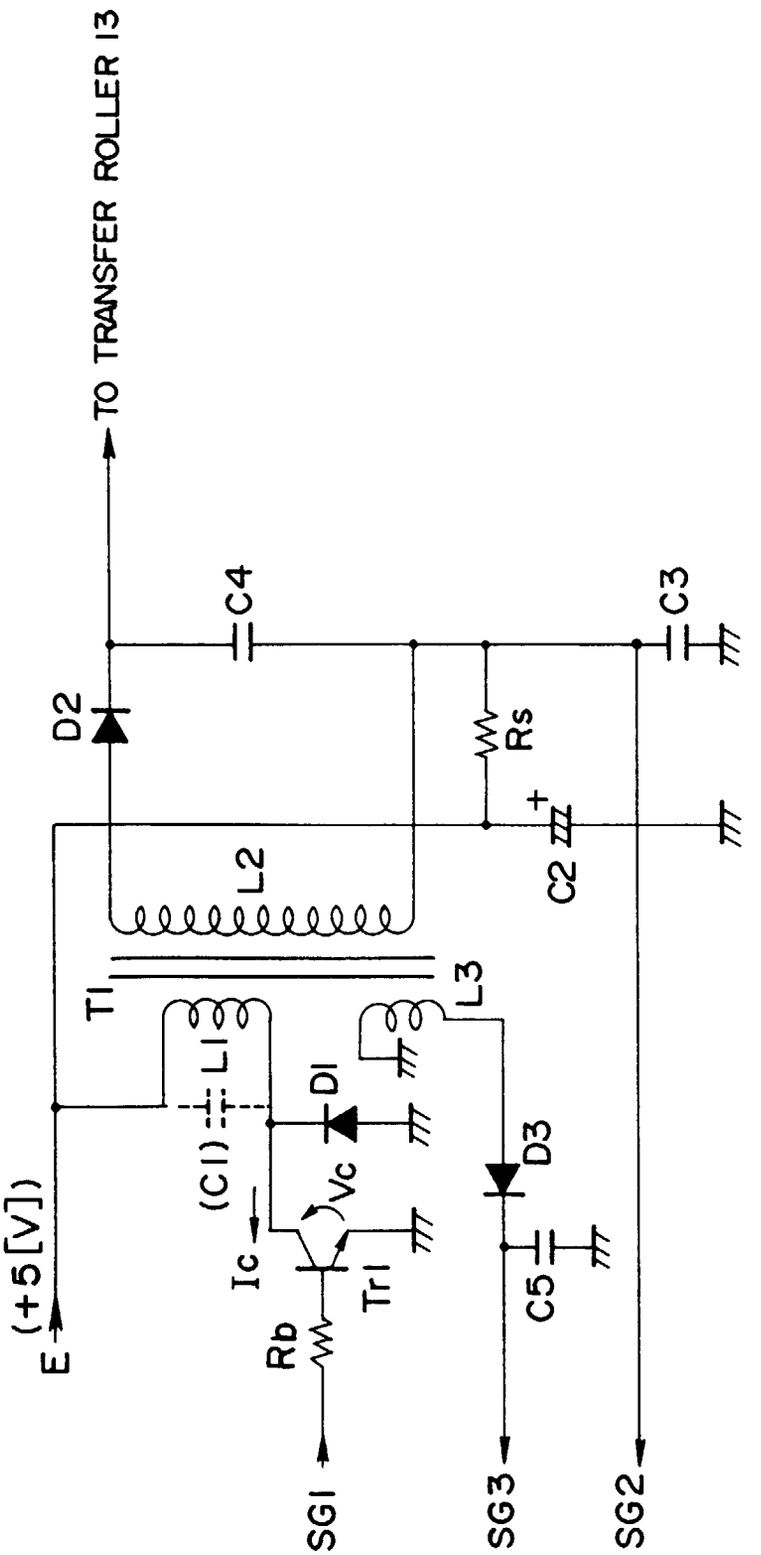

TO TRANSFER ROLLER 13
C4
C3
D2
Rs
C2
L2
T1
L3
L1
D1
(C1)
Vc
D3
Ic
Tr1
C5
E (+5[V])
Rb
SG1
SG3
SG2

FIG. 12

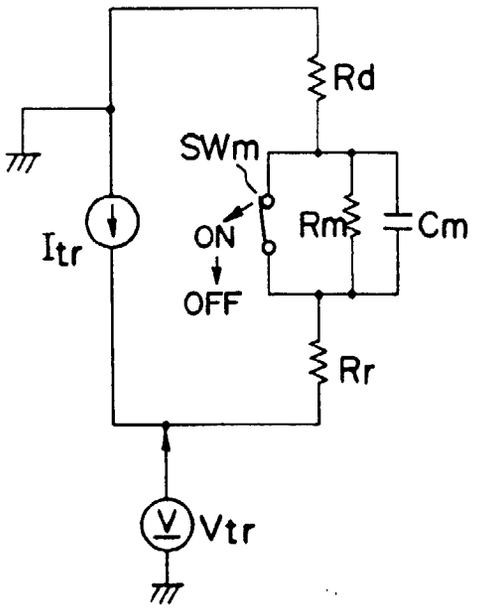

Rd
SWm
ON
OFF
Rm
Cm
Itr
Rr
V
Vtr

FIG. 13

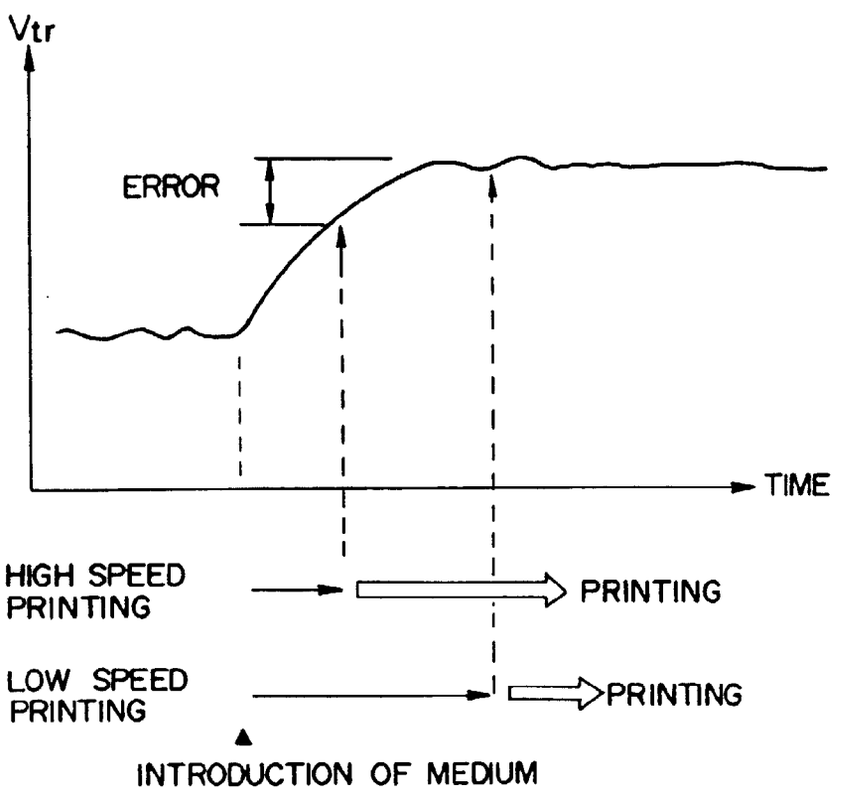

Vtr
ERROR
TIME
HIGH SPEED PRINTING
PRINTING
LOW SPEED PRINTING
PRINTING
INTRODUCTION OF MEDIUM

FIG. 14

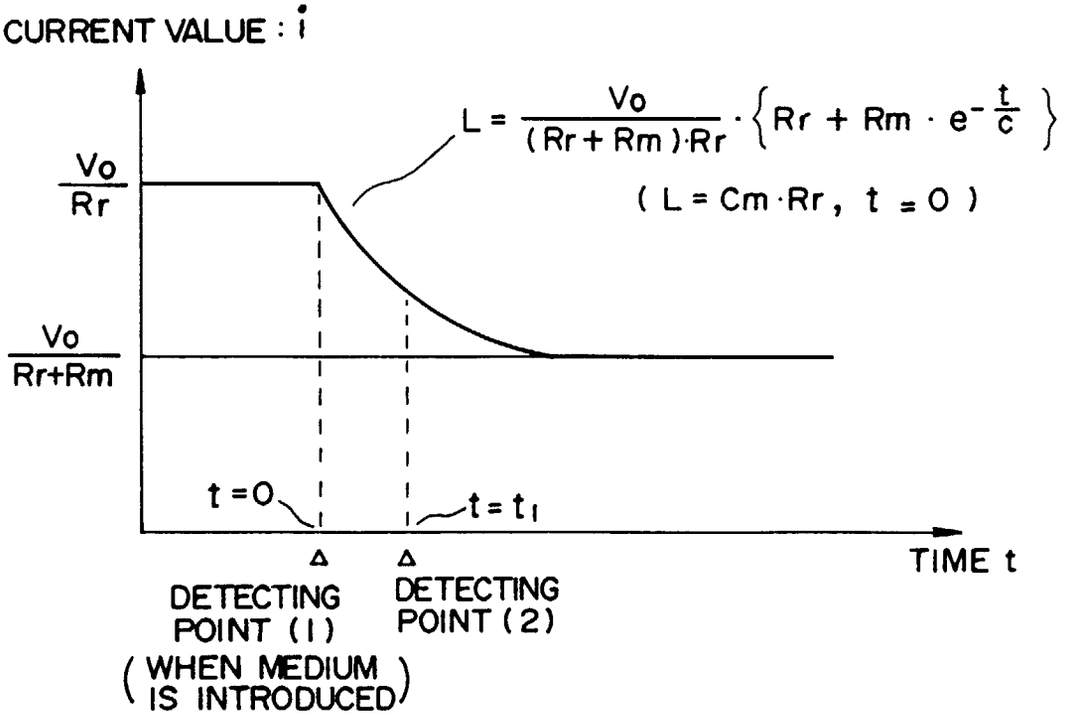
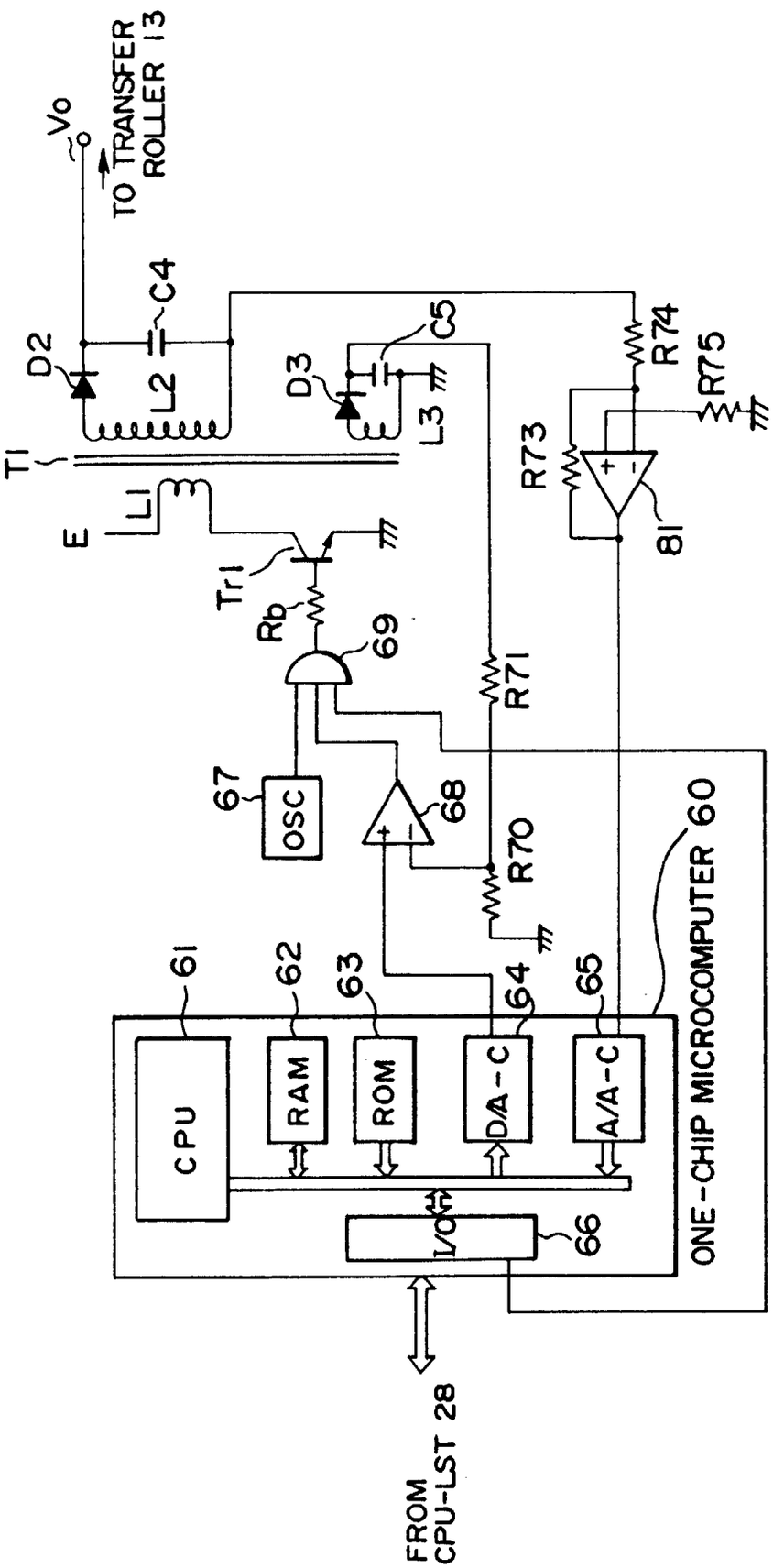

CURRENT VALUE : i
L = Vo/(Rr+Rm)·Rr · {Rr + Rm · e^(-t/c)}
(L = Cm·Rr , t = 0)
Vo/Rr
Vo/Rr+Rm
t = 0
t = t1
TIME t
DETECTING POINT (1)
(WHEN MEDIUM IS INTRODUCED)
DETECTING POINT (2)

FIG. 15


Vo
TO TRANSFER ROLLER 13
C4
C5
D2
D3
L2
L3
T1
L1
E
Tr1
Rb
69
R71
R73
R74
R75
81
67
OSC
68
R70
61
62
63
64
65
CPU
RAM
ROM
D/A-C
A/A-C
I/O
66
ONE-CHIP MICROCOMPUTER 60
FROM CPU-LST 28